The Treasures of Schematising

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Summary

The Treasures of Schematising:
The Effects of Schematising in Early Childhood on the Learning Processes and Outcomes in Later Mathematical Understanding

I would like to start by giving attention to the title of this dissertation: The treasures of schematising. This title is chosen because I think schematising contains a treasure of potentials for the development of mathematical thinking.

The theme of this thesis was 'schematising in early childhood education'. A schematising activity is every cognitive activity whose purpose is to construct and improve symbolic representations of the physical and the sociocultural reality. This participation was studied by means of an intervention in which the effect of introduction and training of schematising in early childhood on later mathematical learning outcomes was compared to the results of a control condition in which there was no introduction of schematising. In the literature, little or no research was found into the effects of schematising on mathematical understanding.

The research question was as follows: What are the effects of introducing schematising to five and six year old children in an experimental setting on their mathematical understanding at age seven, compared to the learning outcomes of pupils in a control group where children did not practice schematising activities?

We expected the children in the experimental condition to perform better on mathematics at the age of seven in the third grade of the Dutch educational system. Particularly these children would be better able to make dynamic schematisations, i.e. schemes which show relations such as processes or changes. Dynamic schematising forms a preparation on mathematical thinking. Therefore, pupils would be better able to solve dynamic sums. Examples are assignments in which number-lines and arrows are used to represent transformations. Conversely, the results on other sums in which '+' and '-' are used would not be different from children in the control condition, because less understanding is required for these type of sums. When children learn to schematise, they learn about the use and function of symbolic representations. Therefore they know how they can represent their reality, ideas and mathematical thoughts in a mathematical way.

The research question was examined in several investigations: a case study and a quasi-experimental study. The results are presented by means of four studies.

In chapter 2, a review study was described. This study formed a foundation for our research project.

In chapter 3, we presented the first study. In order to determine the effects of teaching schematising to children on their mathematical

understanding, we created an experimental group in which particular attention was paid to schematising. We expected that these children would outperform a control group on schematising. In order to test this hypothesis, two tests were administered: the 'Schematising test' and 'Arrow Language'. By means of a specially designed test, the 'Schematising Test,' we were able to establish that pupils from our experimental condition demonstrated more schematising skills than pupils in the control condition.

The development of schematising abilities appeared to be more than just a consequence of autonomous development. Instead, we determined that schematising is an activity that can be developed through teaching and learning. Following this confirmation of our earlier hypothesis and in order to be able to draw valid conclusions, an experimental condition was created so that we could evaluate differences between the experimental and control group's learning outcomes in later development.

The results of the 'arrow language test' made it apparent that the experimental group had a significantly higher score on the section that required dynamic schematisation, a skill which requires more sophisticated mathematical understanding.

In chapter 4 we presented the second study in which we went more deeply into the process of schematising. Our purpose was to determine the effect of introducing schematising to children on their learning processes in the classroom community. Would the schematisations produced by the children be of better quality and would schematising become an integral aspect of the classroom community? Was it more effective to learn schematising skills in collective activities? In this case studied, we expected the children to use schematic forms that were self-evident, to negotiate the forms and meanings of schematisations and to demonstrate certain strategies. Our findings supported our belief that schematising would indeed become a more important aspect of the classroom community in the experimental condition and that the schematisations produced would be of a higher quality than those attempted by the control condition. Children in the experimental group had developed collective rules, norms, beliefs and a more sophisticated understanding of schematising.

Chapter 5 described the outcomes of an empirical study based on a quasi-experimental pre-test post-test control group design (N=133). The learning results on the pre-test and the post-test in both conditions were analysed in order to determine whether our experiment resulted in the expected positive effect on the learning outcomes for mathematics in grade three (age seven). As presented in detail in Chapter 5, in the experimental group, the children's learning outcomes were indeed significantly higher when compared to the control condition's results after half a year of third grade education. Children in the experimental condition clearly benefited from the intervention which was designed to build the bridge between informal and formal thinking. Children in the control group demonstrated a marked downturn in their learning outcomes

likely due to the fact that they were experiencing difficulty when confronted with the sudden change in modes of thought (from concrete practical thinking to logical symbolical thinking). Clearly, they were lacking the tools to enable them to shift between these modes of thought. In order to determine the durability of impact of the intervention a 'Retentiontest' was administered. The outcomes of this test indicate that the learning gain was faded in a year after the intervention.

The case study described in chapter 6, has taken place on one school in the second grade of the Dutch educational system. We endeavoured to outline the stumbling blocks that children have to overcome in schematising. We analysed several schematising activities undertaken by one of the experimental groups, a group which we had previously determined to have average learning outcomes in language and arithmetic. We believe that, if we are aware of the possible stumbling blocks encountered by children, we will be able to anticipate and thus avoid them. This level of preparation would foster the development of schematising and, almost certainly, enhance learning outcomes.

Chapter 7 presented the conclusions and discussion of this dissertation. The results as represented in chapter 3, 4 and 5 clearly showed positive effects of the experimental program. The theoretical discussion and the research results indicated that learning to schematise in early childhood education is a promoting factor of later mathematical thinking.

In view of the promising positive effects we found resulting from the introduction of schematising activities on children's learning processes and outcomes, it would be worthwhile to explore and expand some of the issues presented by this research study. This additional research could extend the intervention period and explicitly reintroduce schematising in the third and fourth grades of the Dutch educational system to determine if the positive effect can be retained through repeated reinforcement of schematising skills in the children's further mathematical development. Also, children's mathematical attitude should be repeatedly measured. During this intervention period, schematising should be embedded in the leading activities of the children at the age of five till ten. With this increased reinforcement, schematising is likely to become a meaningful practice for children. In our research we found evidence that 'schematising' can become a part of the classroom culture. It seems plausible to assume that this tendency to schematise, will eventually be interiorised in the individual pupils as a schematising disposition (attitude). Further research should investigate this hypothesis. This strategy may eventually lead to improved learning outcomes in older pupils as well. Extending this research is essential for enhancing our knowledge of mathematical understanding and also for realising better-quality educational practices in the future.